**Revised Syllabus**
**Under NEP-2020**
# M.Sc. Environmental Sciences
***W.e.f.*** **Academic Session 2025-2026 onwards**

## 1. Course structure for 2-Year M.Sc. Program

## First Semester for 2-year M.Sc. program

| **Entry requirement** | 3-year Bachelor's degree (minimum 120 credits) or 4-Year Bachelor's Degree (In case of B.Tech and B.E programme- Minimum-160 credits) and candidates who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations. | | | | | |
|---|---|---|---|---|---|---|
| **Semester** | **Course category** | **Course Code** | **Course title** | **Credits** | | **Total Credit** |
| | | | | **T** | **P** | |
| **I** | **Discipline Specific Core** | SOLS/EVS-C-001 | **DSC-1** Fundamentals of Environmental Sciences | **5** | - | **5** |
| | | SOLS/EVS- C-002 | **DSC -2** Natural Resource Management | **5** | | **5** |
| | | SOLS/EVS-C-003 | **DSC** -3 Environmental Chemistry and Instrumentation | **5** | **-** | **5** |
| | | SOLS/EVS-C-004 | DSC Practical | **-** | **3** | **3** |
| | **Discipline Specific Elective** (Any 1 out of Minimum 2 electives) **Or** **SWAYAM Course** (Any 1 out of Minimum 2 course) | SOLS/EVS-E-001 | **DSE-1** Man and Environment | **4** | **-** | **4** |
| | | SOLS/EVS-E-002 | **DSE-2** Traditional Ecological Knowledge | | | |
| | | SOLS/EVS-E-003 | DSE Practical *Or* Field Work / Project Work | **-** | **2** | **2** |
| | | - | **SWAYAM 1** Climate and Environmental Protection | **6** | **-** | **6** |
| | | - | **SWAYAM 2** Rural Water Resource Management | | | |
| **Total** | | | | **19** | **5** | **24** |

**Note:** ***1. In lieu of only Elective Practical (2 credits) the departments may offer 2 credit additional course (Field work/Project).***

## Second Semester for 2-year M.Sc. program

| **Semester** | **Course category** | **Course Code** | **Course title** | **Credits** | | **Total Credit** |
|---|---|---|---|---|---|---|
| | | | | **T** | **P** | |
| **II** | **Discipline Specific Core** | SOLS/EVS-C-005 | **DSC-1** Ecosystem services and their Valuation | **5** | **-** | **5** |
| | | SOLS/EVS-C-006 | **DSC -2** Biodiversity Conservation and Restoration Ecology | **5** | | **5** |
| | | SOLS/EVS-C-007 | **DSC** -3 Environmental Monitoring and Pollution Control | **5** | **-** | **5** |
| | | SOLS/EVS-C-008 | DSC Practical | **-** | **3** | **3** |
| | **Discipline Specific Elective** (Any 1 out of Minimum 2 electives) | SOLS/EVS-E-004 | **DSE-1** Environment Vs Development | **4** | **-** | **4** |
| | | SOLS/EVS-E-005 | **DSE-2** Mountain Ecology | | | |
| | | SOLS/EVS-E-006 | DSE Practical | **-** | **2** | **2** |
| **Total** | | | | **19** | **5** | **24** |
| **NHEQF Level-6** | ***Student on exit after successfully completing first year of two-year PG programme (i.e., securing minimum required 48 credits will be awarded "Postgraduate Diploma" of one year, in related field/discipline/subject.*** | | | | | |

# Third Semester for 2-year M.Sc. program

| Semester | Course category | Course Code | Course title | Credits | | Total Credit |
|---|---|---|---|---|---|---|
| | | | | T | P | |
| **III** | **Discipline Specific Core** | SOLS/EVS-C-009 | **DSC-1** Environmental Economics and Sustainable Development | **5** | **-** | **5** |
| | | SOLS/EVS-C-010 | **DSC -2** Climate Change Adaptation and Mitigation | **5** | | **5** |
| | | SOLS/EVS-C-011 | **DSC** -3 Remote sensing, GIS and Environmental Modeling | **5** | **-** | **5** |
| | | SOLS/EVS-C-012 | DSC Practical | **-** | **3** | **3** |
| | **Discipline Specific Elective** (Any 1 out of Minimum 2 electives) | SOLS/EVS-E-007 | **DSE-1** Research Methodology and Environmental Statistics | **4** | **-** | **4** |
| | | SOLS/EVS-E-008 | **DSE-2** Environmental Microbiology, Biotechnology and toxicology | | | |
| | | SOLS/EVS-E-009 | DSE Practical | **-** | **2** | **2** |
| **Total** | | | | **19** | **5** | **24** |

# Fourth Semester for 2-year M. Sc. program

| Semester | Course category | Course Code | Course title | Credits | | Total Credit |
|---|---|---|---|---|---|---|
| | | | | T | P | |
| **IV** | **Discipline Specific Core** | SOLS/EVS-C-013 | **DSC-1** Environmental Management: EIA and Environmental Auditing | **5** | **-** | **5** |
| | | SOLS/EVS-C-014 | **DSC -2** Environmental Laws, Ethics and Policies | **5** | | **5** |
| | | SOLS/EVS-C-015 | **DSC** -3 Environmental Geosciences and Disaster Management | **5** | **-** | **5** |
| | | SOLS/EVS-C-016 | DSC Practical | **-** | **3** | **3** |
| | **Discipline Specific Elective** (Any 1 out of Minimum 2 electives) *Or* Dissertation/ Industrial Training | SOLS/EVS-E-010 | **DSE-1** Spring-shed Conservation and Management | **4** | **-** | **4** |
| | | SOLS/EVS-E-011 | **DSE-2** Himalayan Wildlife Management | | | |
| | | SOLS/EVS-E-012 | DSE Practical | **-** | **2** | **2** |
| **Total** | | | | **19** | **5** | **24** |
| **NHEQF Level- 6.5** | ***Student on successfully completing two-year PG programme (i.e., securing minimum required 96 credits will be awarded "Postgraduate Degree", in related field/discipline/subject.*** | | | | | |

**Note: 1.** ***In lieu of elective (Theory and practical= 4+2 credits) the students [Securing more than 75% marks (7.5 CGPA) in First Year (1st & 2nd Semester)] may opt Dissertation/Industrial training of 6 credits.***

# 2. Course structure for 1-Year M. Sc. program

## First Semester for 1-year M. Sc. program

| Entry requirement | 4-year bachelor's degree (minimum 160 credits), and candidates who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations. | | | | | |
|---|---|---|---|---|---|---|
| **Semester** | **Course category** | **Course Code** | **Course title** | **Credits** | | **Total Credit** |
| | | | | **T** | **P** | |
| **I** | **Discipline Specific Core** | SOLS/EVS-C-001 | **DSC-1** Environmental Economics and Sustainable Development | **5** | **-** | **5** |
| | | SOLS/EVS-C-002 | **DSC -2** Climate Change Adaptation and Mitigation | **5** | | **5** |
| | | SOLS/EVS-C-003 | **DSC** -3 Remote sensing, GIS and Environmental Modeling | **5** | **-** | **5** |
| | | SOLS/EVS-C-004 | DSC Practical | **-** | **3** | **3** |
| | **Discipline Specific Elective** (Any 1 out of Minimum 2 electives) **Or** **SWAYAM Course** (Any 1 out of Minimum 2 course) | SOLS/EVS-E-001 | **DSE-1** Research Methodology and Environmental Statistics | **4** | **-** | **4** |
| | | SOLS/EVS-E-002 | **DSE-2** Environmental Microbiology, Biotechnology and toxicology | | | |
| | | SOLS/EVS-E-003 | DSE Practical *Or* Field Work / Project Work | **-** | **2** | **2** |
| | | - | **SWAYAM 1** Environment and Development | **6** | **-** | **6** |
| | | - | **SWAYAM 2** Municipal Solid Waste Management | | | |
| **Total** | | | | **19** | **5** | **24** |

**Note: 1.** ***In lieu of only Discipline Elective Practical (2 credits) the departments may offer 2 credit additional course (Field work/Project).***

## Second Semester for 1-year M. Sc. program

| **Semester** | **Course category** | **Course Code** | **Course title** | **Credits** | | **Total Credit** |
|---|---|---|---|---|---|---|
| | | | | **T** | **P** | |
| **II** | **Discipline Specific Core** | SOLS/EVS-C-005 | **DSC-1** Environmental Management: EIA and Environmental Auditing | **5** | **-** | **5** |
| | | SOLS/EVS-C-006 | **DSC -2** Environmental Laws, Ethics and Policies | **5** | | **5** |
| | | SOLS/EVS-C-007 | **DSC** -3 Environmental Geosciences and Disaster Management | **5** | **-** | **5** |
| | | SOLS/EVS-C-008 | DSC Practical | **-** | **3** | **3** |
| | **Discipline Specific Elective** (Any 1 out of Minimum 2 electives) *Or* Dissertation/ Industrial Training | SOLS/EVS-E-004 | **DSE-1** Spring-shed Conservation and Management | **4** | **-** | **4** |
| | | SOLS/EVS-E-004 | **DSE-2** Himalayan Wildlife Management | | | |
| | | SOLS/EVS-E-006 | DSE Practical *Or* Field Work / Project Work | **-** | **2** | **2** |
| **Total** | | | | **19** | **5** | **24** |
| **NHEQF Level- 6.5** | ***Student on successfully completing one-year PG programme (i.e., securing minimum required 48 credits will be awarded "Postgraduate Degree", in related field/discipline/subject.*** | | | | | |

**Note: 1.** ***In lieu of elective (Theory and practical= 4+2 credits) the students may opt Dissertation/project work/Industrial training of 6 credits.***

## First Semester for 2-year M.Sc. program

**Course Code: SOLS/EVS-C- 001**
**Course Title: DSC-1 Fundamentals of Environmental Sciences (05 credits)**

**Unit I. Introduction to Environmental Science**

**1.1** Definition, scope and importance of Environmental Sciences
**1.2** Components of environment: atmosphere, hydrosphere, lithosphere and biosphere
**1.3** Human Influence on the Environment: Biosphere-2, Noosphere and Technosphere
**1.4** Various activities under national environment awareness Campaigns (NEAC)

**Unit II. Ecosystem**

**2.1** Structure and Function of an ecosystem
**2.2** Major ecosystems: Himalaya, Marine ecosystems, Deserts, Freshwater ecosystems, Forests and Antarctica ecosystem
**2.3** Food chain, food web and ecological pyramids
**2.4** Energy pathways and ecological processes
**2.5** Ecosystem productivity (primary and secondary)
**2.6** Biogeochemical cycles: Nitrogen, Carbon, Phosphorus, Sulphur, Water and Oxygen

**Unit III. Population, Community, Ecological Succession**

**3.1** Characteristics of population
**3.2** Population growth
**3.3** Concept and characteristics of communities (concept of habitat, niche, keystone species, dominant species, flagship species and ecotones)
**3.4** Ecological succession: primary and secondary succession, climax communities and trends in succession
**3.5** Ecological adaptations (Air, Hill, Stream water, Desert and Deep Sea)

**Unit IV. Self Sustenance of Ecosystem**

**4.1** Homeostasis and Self-Regulation in Ecosystems
**4.2** Ecosystem Stability, Resilience and Adaptation
**4.3** Biodiversity as a Key to Ecosystem Stability
**4.4** Factors Influencing Ecosystem Sustainability

**Course Code: SOLS/EVS- C-002**

**Course Title: DSC-2 Natural Resource Management (05 credits)**

**Unit I. Fundamentals of Natural Resource Management**

- **1.1** Natural resources: concepts, types, distribution and consumption pattern
- **1.2** Factors influencing resource availability
- **1.3** Ecosystem services by various natural resources
- **1.4** Resource management paradigms

**Unit II. Forest and Wildlife Resources and their Management**

- **2.1** Forest resources: Major Forest types, their characteristics and distribution status of forest cover of India
- **2.2** Forest use and over exploitation: Timber extraction, infrastructure development, dams and their effects on forests and tribal communities
- **2.3** Forest conservation and management practices
- **2.4** Wildlife resources: current status, services and threats
- **2.5** Human-wildlife conflict and its resolution
- **2.6** Principles and practices of wildlife management

**Unit III. Water Resources and their Management**

- **3.1** Water resources: Historical background, world scenario and current challenges, status of surface and groundwater
- **3.2** Water resources in Uttarakhand (glaciers, lakes and rivers of Uttarakhand), utilization pattern; Drainage systems of Ganga, Yamuna and Ramganga.
- **3.3** Use and over exploitation of surface and ground waters
- **3.4** Integrated Water Resource Management (IWRM): Key challenges and issues
- **3.5** Legal aspects of water resources and management

**Unit IV. Energy Resources and their Management**

- **4.1** Definition, concept and classification of energy resources
- **4.2** Non-renewable energy resources (fossil fuels, nuclear energy, hydrogen fuel cell)
- **4.3** Renewable energy resources (solar energy, wind energy, hydropower energy, tidal energy, geo-thermal energy)
- **4.4** Energy Management: energy crisis, energy audit, sustainable use of energy resources, alternate energy sources, future energy options and challenges

**Course Code: SOLS/EVS-C- 003**
**Course Title: DSC-3 Environmental Chemistry and Instrumentation (05 credits)**

**Unit I. Fundamentals of Environmental Chemistry**

- **1.1** Stochiometry
- **1.2** Laws of Thermodynamics and Gibbs energy
- **1.3** Chemical potential
- **1.4** Chemical kinetics and Chemical equilibrium
- **1.5** Solubility product
- **1.6** Concentration Units (Normality, Molarity and Molality
- **1.7** Saturated and unsaturated hydrocarbons
- **1.8** Radionuclides
- **1.9** Redox Potential

**Unit II. Atmospheric chemistry**

- **2.1** Tropospheric chemistry
- **2.2** Atmospheric aerosols and gaseous pollutants
- **2.3** Mixing height/depth, Lapse rates and Gaussian plume model
- **2.4** Smog and Fog
- **2.5** Black carbon
- **2.6** Stratospheric chemistry

**Unit III. Water Chemistry**

- **3.1** Physico-chemical properties of water
- **3.2** Hydrological Cycle
- **3.3** Sedimentation, Coagulation, flocculation, filtration
- **3.4** Freshwater chemistry
- **3.5** Chemistry of marine water and major ions
- **3.6** Carbonate system

**Unit IV. Soil Chemistry**

- **4.1** Inorganic and organic components of soil
- **4.2** Mechanism of rock weathering
- **4.3** Soil pH, Nitrogen pathways
- **4.4** NPK in soil

**Unit V. Instrumentation Techniques**

- **5.1** Titrimetry, Gravimetry
- **5.2** Flame photometry
- **5.3** Spectrophotometry (UV-VIS, AAS, ICP-MS)
- **5.4** Chromatography- Paper, TLC, GLC, HPLC
- **5.5** Electrophoresis

**Course Code: SOLS/EVS-C- 004**

**Course Title: DSC Practical** **(03 Credits)**

1. Analysis of various components of ecosystems.
2. Determination of soil texture in different terrestrial habitats.
3. Calculation of frequency, density and abundance of different ecosystem.
4. Calculation of Importance Value Index (IVI) for grassland ecosystems/forest patches.
5. Monitoring of biological diversity and calculation of Shannon Wiener diversity index in aquatic/ terrestrial habitats.
6. To inventory of natural resources of any forest ecosystem located in nearby area.
7. To study the ecosystem services by various natural resources.
8. To study the effects of dams on the forest resources and tribal communities.
9. To understand the drainage systems of river Ganga, Yamuna and Ramganga.
10. To study the measure Renewable energy resources of Uttarakhand.
11. 11. Determination of dissolved oxygen, BOD and COD in a given water samples.
12. Determination of Total solid, total dissolved solids (TDS) and total suspended solids in a water sample.
13. Determination of alkalinity, acidity and total hardness in given water samples.
14. Determination of chloride in a given water samples.
15. Determination of heavy metals in water and soil samples.

**Course Code: SOLS/EVS-E- 001**
**Course Title: DSE-1 Man and Environment (04 credits)**

**Unit I. Man and Environment Relationship**

- **1.1** Pre-historic man and Environment
- **1.2** Hunting and Gathering society and Environment
- **1.3** Pastoralism and Environment
- **1.4** Agro-society and Environment
- **1.5** Industrial society and Environment
- **1.6** Future Society (Sustainable Society)

**Unit II. Fundamentals of Environmental Sociology**

- **2.1** Definition, concepts, issues and scope of Environmental Sociology
- **2.2** Concept of caste, tribe, clan, society and social structure
- **2.3** Cultural Resources
- **2.4** Indigenous/traditional wisdom for Environmental protection

**Unit III. Religion, Culture and Environment**

- **3.1** Role of religion, culture, belief and traditions in conserving environment
- **3.2** Hinduism and The Environment
- **3.3** Buddhism and The Environment
- **3.4** Islam and The Environment
- **3.5** Christianity and The Environment
- **3.6** Jainism and The Environment
- **3.7** Sikhism and The Environment

**Unit IV. Environmental Ethics and Moral**

- **4.1** Definition and concept of Environmental Ethics
- **4.2** Resource consumption patterns and need for equitable utilization
- **4.3** Anthropocentrism, stewardship, biocentrism, ecocentrism, Cosmo centrism
- **4.4** Conservation ethics, traditional value system in India
- **4.5** Sacred Landscapes, Sacred grooves and Sacred species

**Course Code: SOLS/EVS-E- 002**
**Course Title: DSE-2 Traditional Ecological Knowledge (04 credits)**

**Unit I. Introduction**

**1.1.** Definition, concept, and scope of TEK
**1.2.** Traditional ecological knowledge as a science
**1.3.** TEK in different forms (stories, legends, folklore, rituals, folk songs, and dictums)
**1.4.** Traditional technology of subsistence (artifacts, crafts *etc.*)
**1.5.** Language and traditional knowledge

**Unit II. Cultural, Sacred, Myth, Rituals and Beliefs**

**2.1.** Basic concept of society, culture and religion
**2.2.** Nature, aims and objectives of comparative religion (caste, community and their culture).
**2.3.** Basic feature of religion and principal sets of religion
**2.4.** Myths, rituals and beliefs associated with TEK in Hinduism, Buddhism, Islam and Christainity
**2.5.** TEK in Indian Himalayan states

**Unit III. TEK and Natural Resources Management**

**3.1.** TEK for forest conservation,
**3.2.** TEK for water harvesting,
**3.3.** TEK for wildlife case study
**3.4.** TEK for conservation of biodiversity
**3.5.** TEK related with medicinal plants
**3.6.** TEK related with agriculture and cattle rearing
**3.7.** TEK related with horticulture

**Unit IV. Knowledge Transfer: Old Concepts and Barriers**

**4.1.** Old concepts and barriers in transferring indigenous traditional knowledge
**4.2.** Old myths in transferring traditional knowledge
**4.3.** God and man
**4.4.** Ways of prayers, rituals in different communities

**Unit V. Documentation and Preservation of TEK**

**5.1.** Need for Documentation and Preservation
**5.2.** International laws and policy of TEK
**5.3.** Laws and policy in India for TEK

**Course Code: SOLS/EVS-E- 003**

**Course Title: DSE Practical**

**(02 credits)**

**(DSE-1 Man and Environment)**

1. To study the various stages of human evolution.
2. To study the artifacts of ancient human.
3. To study the social structure of communities in nearby area.
4. To study the environmental concerns in various religions.
5. To study traditional conservational ethics in various Indian communities.

***OR***

**(DSE-2 Traditional Ecological Knowledge)**

1. To study origin and evolution of various environmental movement.
2. Preparation of an inventory of TEK for water conservation.
3. Preparation of an inventory of TEK for biodiversity conservation.
4. Preparation of an inventory of TEK related to medicinal plants.
5. Documentation of traditional technology of subsistence (Artifacts, Crafts, Handlooms etc.)

**SWAYAM 1: Climate and Environmental Protection**

**By Prof. B S Balaji, Chairperson, Special Centre for E-Learning and Professor in School of Biotechnology| Jawaharlal Nehru University, New Delhi**
**https://onlinecourses.swayam2.ac.in/ugc25_ge08/preview**

**Course layout**

**Week wise schedule (including the assignment to be kept in the week):**

**Week 1**

- Introduction to Arctic
- Arctic-definition
- Arctic overview-part-1

**Week 2**

- Arctic overview-part-2
- Arctic expedition-Part 1
- Arctic expedition-Part 2

**Week 3**

- Solar irradiance and Albedo
- Albedo, Evapotranspiration
- Arctic-amplification

**Week 4**

- Arctic-amplification-contributors
- Arctic Aerosols and Mechanisms-Part 1
- Arctic Aerosols and Mechanisms-Part 2: Short-lived climate forcers (SLCFs)

**Week 5**

- Arctic Cryosphere and Glacier Change Mechanism
- Plant-biodiversity-Part-1
- Plant-biodiversity-Part-2

**Week 6**

- Animal-biodiversity-Part-1
- Animal-biodiversity-Part-2

**Week 7**

- Marine biodiversity
- Biogeochemical cycle and arctic-Part-1

**Week 8**

- Biogeochemical cycle and arctic-Part-2
- Carbon cycle and Arctic
- Anti-freeze proteins Part 1

**Week 9**

- Anti-freeze proteins Part 2
- Persistent Pollutants in the Arctic
- Methanogenesis, Mechanisms, Pathways, and its Relevance to the Arctic

**Week 10**

- Ocean Acidification
- Ocean Acidification and trace metal biogeochemistry
- Organic Carbon Recycling and its Influence on the Arctic

**Week 11**

- Marine Contamination in the Arctic
- Permafrost and Biogeochemistry Relationship

**Week 12**

- Arctic Chemical and Climate Stressors
- Chemolithotrophy and Arctic Ecosystems

**Week 13**

- Greenhouse Gases and Climate Change Mechanism in the Arctic
- Halogens and Atmospheric Chemistry in the Arctic

**Week 14**

1. Influence of Ozone and UV Radiation in the Arctic
2. Arctic Water and Carbon Cycle and Climate Change Mechanisms
3. Northern Sea route and climate change

**Week 15**

- Asian countries working in the Arctic region
- NCPOR and arctic studies a brief overview
- Interaction with researchers, opportunities for student

**SWAYAM 2: Rural Water Resource Management**

**By Prof. Pennan Chinnasamy | IIT Bombay**

**https://onlinecourses.nptel.ac.in/noc22_ce45/preview**

**Course layout**

**Week wise schedule (including the assignment to be kept in the week):**

**Week 1**

- Importance of water resource management in India and Introduction to Hydrological Cycle and representations

**Week 2**

- Key Hydrological Parameters 1

**Week 3**

- Key Hydrological Parameters 2

**Week 4**

- Introduction to Groundwater hydrology

**Week 5**

- Groundwater components

**Week 6**

- Surface water hydrology

**Week 7**

- Water Mass Balance Equation

**Week 8**

- Rural water management issues, data challenges and observation records.

**Week 9**

- Rural water resource management infrastructure (engineered)

**Week 10**

- Rural water resource management infrastructure (nature based)

**Week 11**

- Rural hydrological databases for India

**Week 12**

- Remote Sensing data bases for Rural water resources

## Second Semester for 2-year M.Sc. program

**Course Code: SOLS/EVS-C- 005**
**Course Title: DSC-1 Ecosystem Services and their Valuation (05 credits)**

**Unit I. Freshwater Ecosystem**

- **1.1** Definition, concept and scope of Freshwater Ecosystem
- **1.2** Goods and services of freshwater ecosystem
- **1.3** Distribution of Freshwater
- **1.4** Basic concept of Hyporheic biodiversity and crenobiodiversity
- **1.5** Drivers of degradation of freshwater ecosystems and their conservation and management

**Unit II. Terrestrial Ecosystem**

- **2.1** Structure and function of terrestrial ecosystem
- **2.2** Biomes and Biogeographic realms of the worlds
- **2.3** Forest Ecosystem
- **2.4** Grassland Ecosystem
- **2.5** Desert Ecosystem
- **2.6** Goods and services provided by terrestrial ecosystems
- **2.7** Drivers of degradation of terrestrial ecosystems and their conservation and management

**Unit III. Marine Ecosystem**

- **3.1** Definition, concept, history and scope of marine ecology
- **3.2** Marine Ecosystems and their Characteristics
- **3.3** Ecosystem Services of Marine Environments
- **3.4** Drivers of degradation of marine ecology and their conservation and management

**Unit IV. Agro-ecosystem and their Management**

- **4.1** Agriculture in India and the World
- **4.2** Key concepts of Agro-ecosystems
- **4.3** Functional basis for the sustainable management of Agro-ecosystems
- **4.4** Management of Agro-ecosystems

**Unit V. Valuation of Ecosystem Services**

- **5.1** Rationale and Objectives of Valuation
- **5.2** Types of Values: Use, Non-use, Option, and Existence
- **5.3** Overview of Valuation Methods
- **5.4** International Initiative regarding Ecosystem Services: MA,TEEB, IPBES, CICES

**Course Code: SOLS/EVS-C- 006**
**Course Title: DSC-2 Biodiversity Conservation and Restoration Ecology (05 credits)**

**Unit I. Introduction to Biodiversity**

**1.1** Concept and values of biodiversity
**1.2** Biodiversity and ecosystem services
**1.3** Biodiversity at different levels (genetic, species and ecosystem)
**1.4** Magnitude and distribution of biodiversity
**1.5** Biodiversity hotspots and keystone species
**1.6** Threats to biodiversity: Habitat loss and fragmentation, Genetic drift, Inbreeding, Disturbance, Pollution, Climate Change, Overexploitation, Invasive Species, Disease, etc.

**Unit II. Biodiversity: Conservation and Management**

**2.1** Need for biodiversity conservation and management
**2.2** Biodiversity and livelihood security
**2.3** Extinction to species: IUCN threatened species categories, causes of species extinction, endangered species, Red and Green Data Books
**2.4** *In -situ* and *Ex-situ* conservation
**2.5** Biodiversity Act, Rules and Regulations
**2.6** International efforts for conserving biodiversity *viz.*, CITES, CBD, IUCN, MAB, UNEP, UPOV and WTO
**2.7** International treaty on Plant Genetic Resources, International Agreement for conserving biodiversity, wetland conservation, rangeland management

**Unit III. Restoration Ecology**

**3.1** Introduction, concept, history, scope and Future needs of Restoration Ecology
**3.2** Elements of ecological restoration strategies and plans for restoration, Passive restoration (natural recovery) and active restoration
**3.3** Restoration of degraded aquatic ecosystems: springs, rivers and wetlands
**3.4** Restoration of terrestrial ecosystem: forest and landscape

**Unit IV. Management of Restoration Project**

**4.1** Setting goals
**4.2** Planning
**4.3** Action plan
**4.4** Adaptive management
**4.5** Monitoring
**4.6** Legal framework and international agreements
**4.7** Indian guidelines for sustainable mining management

**Course Code: SOLS/EVS-C- 007**
**Course Title: DSC-3 Environmental Monitoring and Pollution Control (05 credits)**

**Unit I. Environmental Monitoring**

**1.1** Concept and objectives of environmental monitoring
**1.2** Global environmental monitoring system (GEMS)
**1.3** National environmental monitoring programmes
**1.4** Bio indicators and biological monitoring

**Unit II. Air and Water Pollution**

**2.1** Major sources of air and water pollution
**2.2** Effects of pollutants on human beings, plants and animals
**2.3** Control measures and management techniques for air and water pollution
**2.4** Sewage and industrial effluent treatment
**2.5** National and international standards for ambient air quality and drinking water quality and effluent water quality
**2.6** Indoor air pollution (Smoke, Hydrocarbons, Particulate matter, VOCs, Radon, CO, Biological pollutants, Formaldehyde / Pressed wood Products)
**2.7** Marine pollution

**Unit III. Noise Pollution**

**3.1** Sources of noise pollution
**3.2** Measurement of noise, exposure levels and standards
**3.3** Impact of noise on human health
**3.4** Noise control and abatement measures

**Unit IV. Radioactive and Thermal Pollution**

**4.1** Radioactive pollution: causes and consequences
**4.2** Radioactive fallout, Chernobyl Accident: Three Mile Island accident, Fukushima radio-active leakage
**4.3** Radioactive waste management
**4.4** Thermal pollution: causes and consequences

**Unit V. Solid Waste Management**

**5.1** Types and major sources of solid waste
**5.2** Waste characteristic: physical, chemical and biological
**5.3** Solid waste and environmental problems
**5.4** Integrated solid waste management of municipal waste
**5.5** E-waste and its management

**Course Code: SOLS/EVS-C- 008**

**Course Title: DSC Practical** **(03 Credits)**

1. Distribution of freshwater sources in your local area.
2. Collection and identification of aquatic diversity in nearby river or streams.
3. To study forest stratification, dominant vegetation, and ecological services in a nearby forest area.
4. A case study of ecosystem services provided by any ecosystem(forest/lake/river).
5. To study the different economic value and valuation methods for ecosystem services.
6. To calculate the Alpha ($\propto$) diversity, Beta ($\beta$) diversity and total diversity of given community.
7. Survey of biological resources in your locality.
8. Assessment of threats to biodiversity of a given region.
9. Preparation of inventory of endangered and extinct species of plants/animals of Garhwal Himalaya.
10. To study the role of key stone species in ecosystem.
11. Determination of total microbial count in water sample.
12. Determination of total count (MPN) of coliform in a water sample.
13. Quantitative analysis of heavy metals in environmental samples. Lead, Cadmium, Mercury, Chromium and Arsenic in air, water and soil samples.
14. Study of risk assessment model through flow chart.
15. Assessment and calculation of toxicity (LD50 / LC 50) through dose response relation.

**Course Code: SOLS/EVS-E- 004**
**Course Title: DSE-1 Environment *Vs* Development (04 credits)**

**Unit I. Growth and Development**

**1.1** Definition, concept and scope of economic growth and development
**1.2** Classical theories of development
**1.3** Contemporary models of development and underdevelopment
**1.4** Poverty, inequality and development
**1.5** Evolution of worldwide awareness about environment and activity of Nations, environment and awareness programs

**Unit II. Resource and Development**

**2.1** Environment and human resources
**2.2** Urbanization and informal sector
**2.3** Agriculture transformation and rural development
**2.4** International aspect of development

**Unit III. Environment *Versus* Development**

**3.1** Development dominant phases at global and National levels
**3.2** Conflict between environment development
**3.3** Environmental Activism
**3.4** Resolution of conflict between environment and development
**3.5** Sustainable Development: Various dimensions

**Unit IV. Controversies Related with Environment and Development**

**4.1** Industrial revolution and environment
**4.2** Hydropower development and environment in the Himalayas
**4.3** Impact of road construction and widening on environment and wildlife
**4.4** Ganga *Bachao / Nadi Bachoa Andolan*
**4.5** Sand mining and environment

**Course Code: SOLS/EVS-E- 005**
**Course Title: DSE-2 Mountain Ecology (04 credits)**

**Unit I. Introduction to Mountain Ecology**

- **1.1** Definition, importance and scope of Mountain Ecology
- **1.2** Characteristics and specificity of mountain ecosystems
- **1.3** Environmental importance of mountains
- **1.4** Indigenous communities of mountains and their livelihood security

**Unit II. Mountain Ecosystem**

- **2.1** Structure and components of Mountain Ecosystem
- **2.2** Geological formations of mountains
- **2.3** Vulnerability of mountain ecosystems
- **2.4** Environmental degradation in mountains

**Unit III. Environmental Hazards in the Mountains**

- **3.1** Landslides, soil erosion and sedimentation
- **3.2** Cloud bursts
- **3.3** Flash floods and river blockades
- **3.4** Avalanches and Glaciers Lake Outburst Floods (GLOF)
- **3.5** Earthquakes
- **3.6** Forest fires

**Unit IV. Conservation and Management of Natural Resources of Mountains**

- **4.1** Natural resources of mountains (Forest, Water, Wildlife and Minerals)
- **4.2** Sustainable exploitation of natural resources
- **4.3** Traditional knowledge for management of natural resources
- **4.4** Social and Economic dimension of mountain's natural resources
- **4.5** National and international efforts for management natural resources of mountains

**Course Code: SOLS/EVS-E- 006**

**Course Title: DSE Practical** **(02 credits)**

**(DSE-1 Environment Vs Development)**

1. To study the origin and genesis of environmental awareness at Global, National and Local level.
2. To know about the famous environmental activists of your region.
3. To study the origin and genesis of environmental movements in your locality.
4. To study the impacts of industrialization on environment.
5. To study the impacts of road construction and widening, Mining and Hydropower development in Himalayan region.

***OR***

**(DSE-2 Mountain Ecology)**

1. Analysis of various components of mountain ecosystem.
2. To study the environmental degradation in mountain ecosystem.
3. Assessment of threats to biodiversity in mountain region.
4. To study the geological formations of mountains.
5. To study the socio-economic status of mountain's natural resources.

# Third Semester for 2-year M.Sc. program

**Course Code: SOLS/EVS-C- 009**
**Course Title: DSC-1 Environmental Economics and Sustainable Development (05 credits)**

**Unit I. Fundamentals of Environmental Economics**

- **1.1** Definition, concepts, issues and scope of Environmental Economics
- **1.2** Concept of the commons, tragedy of commons, externalities (indirect costs), economic goods/ services, supply, demand, intangibles, public goods and bads
- **1.3** Limitations of Environmental Economics

**Unit II. Economic Tools**

- **2.1** Valuing the environment and natural resources
- **2.2** Ecology and equity
- **2.3** Natural resource accounting, cost-benefit analysis
- **2.4** Life cycle assessment (LCA)
- **2.5** Intellectual property rights (IPR) and environment

**Unit III. Sustainable Development**

- **3.1** Principles of Sustainable Development: History and emergence of the concept and definition of Sustainable Development
- **3.2** Goals of Sustainable Development
- **3.3** Stake holders of Sustainable development: People, Government, investor, Industry, Judiciary & international organization working for Sustainable development
- **3.4** From unsustainable to sustainable development

**Unit IV. Urbanization and Environmental Economics**

- **4.1** Urban Growth and Environmental Stress
- **4.2** Economics of Urban Pollution (air, water, waste)
- **4.3** Sustainable Urban Planning and Transport
- **4.4** Green Infrastructure and Urban Resilience
- **4.5** Major environmental movements (Chipko, Appiko, Narmada BachaoAndolan, Tehri dam conflicts and Silent valley movement, Nadi Bachao Andolan, Beej Bachao Andolan)

**Course Code: SOLS/EVS-C- 010**
**Course Title: DSC-2 Climate Change Adaptation and Mitigation (05 credits)**

**Unit I. Introduction to Climatology**

**1.1** Definition, brief history and scope of Climatology
**1.2** Meteorological parameters: temperature, pressure, precipitation, humidity, radiation, wind and clouds
**1.3** Composition, structure and importance of atmosphere
**1.4** Concept of weather , season and Climate

**Unit II. Different Climatological process**

**2.1** Atmospheric heating and cooling, Heat budget and Heat balance, Global temperature circulation
**2.2** Planetary wind pattern and General atmospheric circulation
**2.3** Atmospheric moisture: Condensation and different types of precipitation
**2.4** Atmospheric humidity: Measurement and distribution
**2.5** Oceans and international variations in climate (El Nino, ENSO, La Nina)
**2.6** Natural and atmospheric extreme events: Tropical cyclone, thunder storms, tornadoes, flood, cloud burst, drought

**Unit III. Regional Climatology**

**3.1** Definition, microclimate and meso-climate scale
**3.2** Climate and distribution of vegetation
**3.3** Mid-latitude climate
**3.4** Polar and high land climate

**Unit IV. Applied Climatology or Responses to Climate Change: Adaptation and Mitigation**

**4.1** Natural and Anthropogenic (man- made) causes of climate change
**4.2** Consequences of climate change
**4.3** Climate Change: Biodiversity, agriculture and industry
**4.4** Climate change and Food security
**4.5** Human response to climate
**4.6** Adaptation concepts and strategies
**4.7** Limiting climate change: Adaptation and Mitigation

**UNIT V. Arctic and Polar Affairs**

**5.1** Introduction, history and importance of polar and arctic regions/zones on earth
**5.2** Structure and Specificity of arctic and polar ecosystems
**5.3** Vulnerability of arctic ecosystems
**5.4** Periglacial and terrestrial habitats in arctic and polar regions
**5.5** Arctic and polar species diversity
**5.6** Stress, adaptation and survival in arctic and polar regions
**5.7** Climate change and environmental degradation in arctic and polar zones

**Course Code: SOLS/EVS-C- 011**
**Course Title: DSC-3 Remote Sensing, GIS and Environmental Modeling (05 credits)**

**Unit I. Introduction to Remote Sensing**

- **1.1** Definition, concepts, history and scope of remote sensing
- **1.2** Electromagnetic radiations (EMR) and electromagnetic spectrum
- **1.3** Platforms, sensors and types of scanning systems
- **1.4** Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites
- **1.5** Earth's and atmospheric interaction with EMR and atmosphere window
- **1.6** Spectral reflectance of vegetation, soil and water

**Unit II. Application of Remote Sensing**

- **2.1** Application of remote sensing in EIA
- **2.2** Application of remote sensing in forest management
- **2.3** Application of remote sensing in characterization and monitoring of biodiversity
- **2.4** Application of remote sensing in mapping of wetlands

**Unit III. Geographic Information System (GIS)**

- **3.1** Introduction and basic principle and scope of GIS
- **3.2** Application of GIS in environmental management
- **3.3** Brief outline of Digital Image Processing

**Unit IV. Environmental Modeling**

- **4.1** Definition, concept and role of modeling in Environmental Sciences
- **4.2** Components of a model
- **4.3** Models of population (growth and interaction) and pollution dispersal: Lotka Voltera model, Leslie Matrix model and Gaussian Plume model

**Course Code: SOLS/EVS-C- 012**

**Course Title: DSC Practical** **(03 credits)**

1. To study socio-economic status- Preparing of questionnaire and case studies.
2. Inventorization of local NTPFs.
3. Economic evaluation of a forest area/lake/river.
4. Cost-benefit analysis of a river valley project.
5. Market survey for forest products.
6. Measurement of dry and wet bulb temperature.
7. Recording of wind speed and direction.
8. Preparation of wind roses with the given data.
9. Recording of diurnal variations in temperature
10. To study the impact of global warming on glaciers.
11. Introduction to GIS interface (QGIS/ArcGIS)
12. Recognition of tone, texture, pattern, and shape in Visual Image Interpretation.
13. Study of electromagnetic spectrum and spectral characteristics.
14. GPS data collection in the field and creating maps from GPS tracks / waypoints
15. Land-use/land-cover (LULC) identification through visual interpretation.

**Course Code: SOLS/EVS-E- 007**

**Course Title: DSE-1 Research Methodology and Environmental Statistics (04 credits)**

**Unit I. Introduction of Research Aptitude**

**1.1** Research: Meaning, Types and Characteristics
**1.2** Positivism and post positivistic approach to research
**1.3** Methods of research
**1.4** Qualitative and Quantitative methods

**Unit II. Various steps in the Research**

**2.1** Identification of research problems
**2.2** Search of literature
**2.3** Experimental design/construction of hypothesis
**2.4** Materials and methods
**2.5** Field study and collection of samples/questionnaire
**2.6** Collection and analysis of data
**2.7** Presentation of data in graphic and tabular form
**2.8** Use of statistical tools
**2.9** Discussion of results/ testing of hypothesis, Citation of references and bibliography

**Unit III. Application of computer in Environmental Research**

**3.1** Use of different software for analysis of data- SPSS, Excel
**3.2** Use of internet and search for literature
**3.3** Format and styles of referencing
**3.4** Writing of thesis and dissertation
**3.5** Plagiarism and research ethics

**Unit IV. Environmental Statistics**

**4.1** Measurement of central tendency- Mean, Mode and Median
**4.2** Dispersion- Standard deviation, Standard error, Mean deviation and Coefficient of variation
**4.3** Moments – measure of Skewness and Kurtosis
**4.4** Distributions - Normal, log-normal, Binomial, Poisson
**4.5** Simple and multiple correlation and regression coefficient
**4.6** Basic laws and concept of probability
**4.7** Test of hypothesis and significance.
**4.8** t, F, chi square tests
**4.9** ANOVA

**Course Code: SOLS/EVS-E- 008**

**Course Title: DSE-2 Environmental Microbiology, Biotechnology and Toxicology (04 credits)**

**Unit I. Basic and Environmental Microbiology**

- **1.1** Introduction, history and scope of Environmental Microbiology
- **1.2** Characteristics of major groups of microbes
- **1.3** Level of microbial diversity, distribution of microorganism and microbes of extreme environment
- **1.4** Microbial pathogen and their control

**Unit II. Microbial Ecology**

- **2.1** Mode of microbial nutrition
- **2.2** Ecological interactions of microbes and indicator microorganism
- **2.3** Effects of environmental factors (light, temperature, moisture, pH) on microorganisms
- **2.4** Biodegradation of organic pollutants by microorganisms
- **2.5** Determination of microbial growth (bacteria and fungi)

**Unit III. Basic and Environmental Biotechnology**

- **3.1** Concept, history and scope of Biotechnology
- **3.2** Plant tissue culture: General introduction, scope, cellular differentiation, totipotency
- **3.3** Recombinant DNA technology: Gene cloning, cDNA libraries, choice of vectors, PCR, DNA finger printing.
- **3.4** Genetic improvement of industrial microbes and nitrogen fixers, fermentation technology, vermiculture technology
- **3.5** Bioremediation: Types, advantages and applications
- **3.6** Bio-indicators, bio-fuels and biosensors

**Unit IV. Environmental Toxicology**

- **4.1** Definition, concept and scope of Environmental Toxicology
- **4.2** Xenobiotics- Dyes and Detergent, Food Additives, Pesticides and Heavy metals
- **4.3** Biotransformation: Principle, biotransformation enzymes, biotransformation for gaseous toxicants
- **4.4** Bioaccumulation: Principle, sub-lethal and indirect effects of bioaccumulation

**Unit V. Toxicity assessment, System Toxicity and Risk Assessment**

- **5.1** *In-vivo* and *in-vitro* toxicity assessment
- **5.2** Acute, sub-acute, sub chronic and chronic toxicity test, concept of bioassay, threshold limit value, margin of safety, therapeutic index
- **5.3** LD50, LC50, EC50, and IC50
- **5.4** Translocation and mechanism of toxicants (Absorption, distribution &excretion of toxic agents)
- **5.5** Risk Assessment (Models, Methods and Management)

**Course Code: SOLS/EVS-E- 009**

**Course Title: DSE Practical** **(02 credits)**

**(DSE-1 Research Methodology and Environmental Statistics)**

1. Experimental design/construction of hypothesis
2. Methods of collection, presentation and analysis of data
3. Measurement of Standard deviation, Standard error, Mean deviation correlation and regression
4. Chi square tests
5. ANOVA

***OR***

**(DSE-2 Environmental Microbiology, Biotechnology and Toxicology)**

1. Preparation of culture media and sterilization techniques
2. Protocol for PCR and DNA finger printing
3. To isolate, culture and mass-multiplication of beneficial microorganisms and prepare a biofertilizer inoculant suitable for soil application.
4. To separate and visualize DNA fragments by size using Agarose Gel Electrophoresis.
5. To assess the acute toxicity of an environmental sample using biological test organisms and determine toxicity endpoints such as $LC_{50}$ (lethal concentration) or $EC_{50}$ (effective concentration).

# Fourth Semester for 2-year M. Sc. program

**Course Code: SOLS/EVS-C- 013**
**Course Title: DSC-1 Environmental Management: EIA and Environmental Auditing (05 credits)**

**Unit I. Environmental Impact Assessment (EIA)**

- **1.1** Concept, scope and objectives of EIA
- **1.2** Evolution of EIA and developmental projects under EIA
- **1.3** Protocol for Environmental Impact Statement (EIS)
- **1.4** EIA guidelines 1994: Notifications of Government of India
- **1.5** EIA Notification 2006 and subsequent modifications

**Unit II. Methods of Impact Analysis**

- **2.1** Procedure of EIA
- **2.2** Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided)
- **2.3** Impact prediction on air, water, land, biota, socio-economic environment
- **2.4** Concept of Cumulative Environmental Impact Assessment (CEIA)

**Unit III. Statuary Clearance Procedure and Public Consultation**

- **3.1** Expert Appraisal Committee(EAC)
- **3.2** Environmental Clearance, Wildlife Clearance and Forest Clearance
- **3.3** State Expert Appraisal Committee (SEAC) and State EIA Authority (SEIAA)
- **3.4** Concept, objectives and procedures of Public Consultation

**Unit IV. Post-Project Monitoring and Environmental Auditing**

- **4.1** Principles and guidelines of environmental auditing
- **4.2** General Audit: Methodology and basic structure of environmental auditing
- **4.3** ISO 14000 series and ISO 9000 series

**Unit V. Environmental Management and Management Plan**

- **5.1** Concept, objectives and scope of environmental management.
- **5.2** Guidelines for EMP
- **5.3** Development of EMP
- **5.4** Rehabilitation and resettlement
- **5.5** Compensatory Afforestation
- **5.6** Green belt development

**Course Code: SOLS/EVS-C- 014**
**Course Title: DSC-2 Environmental Laws, Ethics and Policies (05 credits)**

**Unit I. National and International Efforts for Environmental Protection**

- **1.1** Brief introduction about the structure of Indian Constitution
- **1.2** Environmental protection in the Indian Constitution
- **1.3** Major Environmental issues, challenges and its response at national and international Level
- **1.4** International and national efforts related to environmental Pollution, Climate change, Green house Gas emission, Ozone layer depletion and biodiversity conservation)

**Unit II. National Environmental Laws**

- **2.1** Indian Forest Act 1927; The Forest Conservation Act 1980, and Forest conservation Rules 2003
- **2.2** Wildlife Protection Act 1972 and its successive amendments
- **2.3** Biological Diversity Act 2002 and Biological Diversity Rules 2004
- **2.4** Water (Prevention and Control of Pollution) Act 1974 and Rules 1975 and subsequent amendments
- **2.5** Air (Prevention and Control of Pollution) Act 1981 and Rules 1982 and successive amendments
- **2.6** The Environmental (Protection) Act 1986 and its amendment in 1991, The environment (Protection) Rules 1986
- **2.7** The National Green Tribunal Act 2010
- **2.8** The Public Liability Insurance Act 1991

**Unit III. National Laws related to waste management**

- **3.1** Biomedical Waste Management rules, 2016, as Amended 2019
- **3.2** Hazardous and other waste (Management & Transboundary movement) Rules,
- **3.3** Plastic waste management rules 2016, as amended 2021
- **3.4** Solid waste management rules 2016
- **3.5** E-waste rules 2016 and E-waste (Management) Amendment Rules, 2018

**Unit IV. National Policies**

- **4.1** Forest Policy
- **4.2** Environmental Policy
- **4.3** Water Policy
- **4.4** Disaster Management Policy

**Course Code: SOLS/EVS-C- 015**
**Course Title: DSC-3 Environmental Geosciences and Disaster Management (05 credits)**

**Unit I. Fundamentals of Environmental Geosciences and Earth System**

- **1.1** Definition, concept and scope of Environmental Geosciences
- **1.2** Origin and evolution of the Earth; plate tectonics, rocks and their classification
- **1.3** Relationship among various geospheres
- **1.4** Energy budget and thermal environment of the Earth

**Unit II. Environmental Geochemistry and Land use Planning**

- **2.1** Concept, importance and use of the Earth elements
- **2.2** Weathering, soil formation, soil profile, soil classification and distribution
- **2.3** Land use planning: Soil survey, methods of site selection and evaluation

**Unit III. Earth's Processes and Geological Hazards**

- **3.1** Catastrophic geological hazards, hazards in Himalayan and coastal areas
- **3.2** Terrestrial hazards; floods, landslides, cloud burst, earthquakes, volcanism, avalanche and glacier lake outburst
- **3.3** Coastal hazards; Tsunami, storms in oceans, ice sheets and fluctuation s of sea levels, marine pollution by toxic wastes

**Unit IV. Disaster Management**

- **4.1** Introduction and definition of vulnerability, risk, hazard, disaster and catastrophe
- **4.2** Impact of disaster on economy and society
- **4.3** Disaster management cycle
- **4.4** Disaster management and sustainability
- **4.5** The Disaster Management Act 2005 and subsequent amendments

**Unit V. Disaster Mitigation and Risk Reduction**

- **5.1** Risk and vulnerability assessment
- **5.2** Disaster preparedness; information, education, awareness and communication
- **5.3** Disaster mitigation; approaches and strategies
- **5.4** Disaster response and planning; Search, Rescue and evacuation, damage, community health and casualty management
- **5.5** Disaster recovery: social and economic aspects of rehabilitation and resettlement
- **5.6** Prediction and perception of the hazards
- **5.7** Community based disaster risk reduction strategies

**Course Code: SOLS/EVS-C- 016**

**Course Title: DSC Practical (03 credits)**

1. Presentation of procedure of Environmental Impact Assessment (EIA) through flowchart
2. Presentation of procedure of Environmental Clearance through flowchart
3. Presentation of procedure of Forest Clearance through flowchart
4. Presentation of procedure of Environmental Auditing through flow chart
5. Presentation of procedure of Environmental Management Plan (EMP) through flow chart
6. Presentation of salient features of Wildlife Protection Act 1972
7. Presentation of salient features of Water (Prevention and Control of Pollution) Act 1974
8. Presentation of salient features of the Air (Prevention and Control of Pollution) Act 1981
9. Presentation of salient features of The Environmental (Protection) Act and Rules 1986
10. Presentation of salient features of The Indian Forest Conservation Act 1980
11. To understand the interior of the Earth
12. To understand the process of soil formation
13. To study the soil profile
14. To study the classification and orders of soil
15. To study the various soil types of India

**Course Code: SOLS/EVS-E- 010**

**Course Title: DSE-1 Spring-shed Conservation and Management (04 credits)**

**Unit I: Introduction to Springs and Spring-Sheds**

- **1.1** Definition, scope and importance of spring-sheds
- **1.2** Types and Classification of Springs: Gravity, artesian, contact, fracture, and solution springs.
- **1.3** Hydro-geological Framework of Spring Systems: Structure of aquifers; groundwater flow in mountainous terrains.
- **1.4** Ecological and Socioeconomic Importance of Springs: Role in drinking water, irrigation, biodiversity, and community livelihoods.

**Unit II: Hydrological and Climatic Influences**

- **2.1** Watershed and Spring Hydrology: Rainfall-runoff processes, infiltration, percolation, and aquifer recharge.
- **2.2** Impacts of Land Use and Land Cover Change (LULC): Effects of deforestation, agriculture, road construction, and urbanization.
- **2.3** Climate Change and Seasonal Variability: Impacts on spring discharge, recharge cycles, and long-term water availability.
- **2.4** Monitoring Tools and Techniques: Use of rain gauges, piezometers, flow meters, and soil moisture sensors.

**Unit III: Spring-Shed Management Approaches**

- **3.1** Spring Rejuvenation Techniques: Implementation of recharge structures like trenches, percolation pits, check dams, and ponds.
- **3.2** Delineation and Mapping using GIS & Remote Sensing: Application of geospatial tools for spring-shed mapping and intervention planning.
- **3.3** Community-Based Water Resource Management: Participatory rural appraisal (PRA), stakeholder engagement, and local knowledge integration.
- **3.5** Demand and Supply Side Water Management: Strategies for efficient water use, rainwater harvesting, and equitable distribution.

**Unit IV: Conservation and Policy Perspectives**

- **4.1** National Water Policies and Programs: Overview of Jal Shakti Abhiyan, Atal BhujalYojana, MGNREGA in spring conservation.
- **4.2** Institutional and Governance Framework: Roles of Panchayati Raj institutions, Van Panchayats, NGOs, and water user groups.
- **4.3** Environmental and Social Safeguards: Inclusion of gender, marginalized groups, and mechanisms for conflict resolution.
- **4.4** Ecosystem Services and Valuation of Springs: Assessing provisioning, regulatory, cultural, and supporting services of spring ecosystems.

**Course Code: SOLS/EVS-E- 012**

**Course Title: DSE-2 Himalayan Wildlife Management (04 credits)**

**Unit I. An Introduction to the Himalaya**

- **1.1** Physiography- location, expansion and importance
- **1.2** Origin and evolution of the Himalaya
- **1.3** Himalayan Environment
- **1.4** Natural resources of the Himalaya
- **1.5** Fragility of the mountain ecosystem

**Unit II. Wildlife of the Himalaya**

- **2.1** Unique characteristics and importance of the wildlife
- **2.2** Himalayan biodiversity
- **2.3** Endemism
- **2.4** Depletion of Himalayan wildlife

**Unit III. Manifestation of Himalayan Wildlife**

- **3.1** Himalayan wild Mammals
- **3.2** Himalayan wild Birds
- **3.3** Himalayan Reptiles and Amphibians
- **3.4** Himalayan Fish
- **3.5** Himalayan Butterflies
- **3.6** Rare and Endangered Himalayan wild flora

**Unit IV. Conservation and Management**

- **4.1** Administrative and legislative measures for protection of wildlife
- **4.2** Protected areas (National parks, sanctuaries, biosphere reserves) in the Himalaya
- **4.3** Tiger Project, Project Elephant, Project Rhino, Project Snow Leopard
- **4.4** Man-Wildlife Conflict: agriculture-wildlife conflict
- **4.5** Wildlife Protection Act 1972 and successive amendments
- **4.6** Problems in implementation of the Wildlife Protection Act

**Course Code: SOLS/EVS-E- 012**

**Course Title: DSE Practical** **(02 credits)**

**(DSE-1 Spring-shed Conservation and Management)**

1. To identify, document, and map springs in a designated area.
2. To measure the quantity of water discharged by a spring.
3. To assess the land use and land cover (LULC) of the spring catchment area.
4. To evaluate the basic quality of spring water for human use.
5. To plan and construct basic recharge or conservation structures in a spring-shed.

***OR***

**(DSE-2 Himalayan Wild life management)**

1. Documentation of Wild life conflict hotspots using field mapping & interviews.
2. Mitigation measure evaluation for Himalayan Wild life
3. Preparation of a micro-management plan for a Himalayan wildlife habitat.
4. Assessment of anthropogenic pressures to Himalayan Wild life
5. Preparation of corridor maps for species movement (least-cost path analysis).

# First Semester for 1-year M. Sc. program

**Course Code: SOLS/EVS-C- 001**
**Course Title: DSC-1 Environmental Economics and Sustainable Development (05 credits)**

**Unit I. Fundamentals of Environmental Economics**

- **1.1** Definition, concepts, issues and scope of Environmental Economics
- **1.2** Concept of the commons, tragedy of commons, externalities (indirect costs), economic goods/ services, supply, demand, intangibles, public goods and bads
- **1.3** Limitations of Environmental Economics

**Unit II. Economic Tools**

- **2.1** Valuing the environment and natural resources
- **2.2** Ecology and equity
- **2.3** Natural resource accounting, cost-benefit analysis
- **2.4** Life cycle assessment (LCA)
- **2.5** Intellectual property rights (IPR) and environment

**Unit III. Sustainable Development**

- **3.1** Principles of Sustainable Development: History and emergence of the concept and definition of Sustainable Development
- **3.2** Goals of Sustainable Development
- **3.3** Stake holders of Sustainable development: People, Government, investor, Industry, Judiciary & international organization working for Sustainable development
- **3.4** From unsustainable to sustainable development

**Unit IV. Urbanization and Environmental Economics**

- **4.1** Urban Growth and Environmental Stress
- **4.2** Economics of Urban Pollution (air, water, waste)
- **4.3** Sustainable Urban Planning and Transport
- **4.4** Green Infrastructure and Urban Resilience
- **4.5** Major environmental movements (Chipko, Appiko, Narmada BachaoAndolan, Tehri dam conflicts and Silent valley movement, Nadi Bachao Andolan, Beej Bachao Andolan)

**Course Code: SOLS/EVS-C- 002**
**Course Title: DSC-2 Climate Change Adaptation and Mitigation (05 credits)**

**Unit I. Introduction to Climatology**

- **1.1** Definition, brief history and scope of Climatology
- **1.2** Meteorological parameters: temperature, pressure, precipitation, humidity, radiation, wind and clouds
- **1.3** Composition, structure and importance of atmosphere
- **1.4** Concept of weather , season and Climate

**Unit II. Different Climatological process**

- **2.1** Atmospheric heating and cooling, Heat budget and Heat balance, Global temperature circulation
- **2.2** Planetary wind pattern and General atmospheric circulation
- **2.3** Atmospheric moisture: Condensation and different types of precipitation
- **2.4** Atmospheric humidity: Measurement and distribution
- **2.5** Oceans and international variations in climate (El Nino, ENSO, La Nina)
- **2.6** Natural and atmospheric extreme events: Tropical cyclone, thunder storms, tornadoes, flood, cloud burst, drought

**Unit III. Regional Climatology**

- **3.1** Definition, microclimate and meso-climate scale
- **3.2** Climate and distribution of vegetation
- **3.3** Mid-latitude climate
- **3.4** Polar and high land climate

**Unit IV. Applied Climatology or Responses to Climate Change: Adaptation and Mitigation**

- **4.1** Natural and Anthropogenic (man- made) causes of climate change
- **4.2** Consequences of climate change
- **4.3** Climate Change: Biodiversity, agriculture and industry
- **4.4** Climate change and Food security
- **4.5** Human response to climate
- **4.6** Adaptation concepts and strategies
- **4.7** Limiting climate change: Adaptation and Mitigation

**UNIT V. Arctic and Polar Affairs**

- **5.1** Introduction, history and importance of polar and arctic regions/zones on earth
- **5.2** Structure and Specificity of arctic and polar ecosystems
- **5.3** Vulnerability of arctic ecosystems
- **5.4** Periglacial and terrestrial habitats in arctic and polar regions
- **5.5** Arctic and polar species diversity
- **5.6** Stress, adaptation and survival in arctic and polar regions
- **5.7** Climate change and environmental degradation in arctic and polar zones

**Course Code: SOLS/EVS-C- 003**
**Course Title: DSC-3 Remote Sensing, GIS and Environmental Modeling (05 credits)**

**Unit I. Introduction to Remote Sensing**

- **1.1** Definition, concepts, history and scope of remote sensing
- **1.2** Electromagnetic radiations (EMR) and electromagnetic spectrum
- **1.3** Platforms, sensors and types of scanning systems
- **1.4** Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites
- **1.5** Earth's and atmospheric interaction with EMR and atmosphere window
- **1.6** Spectral reflectance of vegetation, soil and water

**Unit II. Application of Remote Sensing**

- **2.1** Application of remote sensing in EIA
- **2.2** Application of remote sensing in forest management
- **2.3** Application of remote sensing in characterization and monitoring of biodiversity
- **2.4** Application of remote sensing in mapping of wetlands

**Unit III. Geographic Information System (GIS)**

- **3.1** Introduction and basic principle and scope of GIS
- **3.2** Application of GIS in environmental management
- **3.3** Brief outline of Digital Image Processing

**Unit IV. Environmental Modeling**

- **4.1** Definition, concept and role of modeling in Environmental Sciences
- **4.2** Components of a model
- **4.3** Models of population (growth and interaction) and pollution dispersal: Lotka Voltera model, Leslie Matrix model and Gaussian Plume model

**Course Code: SOLS/EVS-C- 004**

**Course Title: DSC Practical** **(03 credits)**

1. To study socio-economic status- Preparing of questionnaire and case studies.
2. Inventorization of local NTPFs.
3. Economic evaluation of a forest area/lake/river.
4. Cost-benefit analysis of a river valley project.
5. Market survey for forest products.
6. Measurement of dry and wet bulb temperature.
7. Recording of wind speed and direction.
8. Preparation of wind roses with the given data.
9. Recording of diurnal variations in temperature
10. To study the impact of global warming on glaciers.
11. Introduction to GIS interface (QGIS/ArcGIS)
12. Recognition of tone, texture, pattern, and shape in Visual Image Interpretation.
13. Study of electromagnetic spectrum and spectral characteristics.
14. GPS data collection in the field and creating maps from GPS tracks / waypoints
15. Land-use/land-cover (LULC) identification through visual interpretation.

**Course Code: SOLS/EVS-E- 001**

**Course Title: DSE-1 Research Methodology and Environmental Statistics (04 credits)**

**Unit I. Introduction of Research Aptitude**

**1.1** Research: Meaning, Types and Characteristics
**1.2** Positivism and post positivistic approach to research
**1.3** Methods of research
**1.4** Qualitative and Quantitative methods

**Unit II. Various steps in the Research**

**2.1** Identification of research problems
**2.2** Search of literature
**2.3** Experimental design/construction of hypothesis
**2.4** Materials and methods
**2.5** Field study and collection of samples/questionnaire
**2.6** Collection and analysis of data
**2.7** Presentation of data in graphic and tabular form
**2.8** Use of statistical tools
**2.9** Discussion of results/ testing of hypothesis, Citation of references and bibliography

**Unit III. Application of computer in Environmental Research**

**3.1** Use of different software for analysis of data- SPSS, Excel
**3.2** Use of internet and search for literature
**3.3** Format and styles of referencing
**3.4** Writing of thesis and dissertation
**3.5** Plagiarism and research ethics

**Unit IV. Environmental Statistics**

**4.1** Measurement of central tendency- Mean, Mode and Median
**4.2** Dispersion- Standard deviation, Standard error, Mean deviation and Coefficient of variation
**4.3** Moments – measure of Skewness and Kurtosis
**4.4** Distributions - Normal, log-normal, Binomial, Poisson
**4.5** Simple and multiple correlation and regression coefficient
**4.6** Basic laws and concept of probability
**4.7** Test of hypothesis and significance.
**4.8** t, F, chi square tests
**4.9** ANOVA

**Course Code: SOLS/EVS-E- 002**

**Course Title: DSE-2 Environmental Microbiology, Biotechnology and Toxicology (04 credits)**

**Unit I. Basic and Environmental Microbiology**

- **1.1** Introduction, history and scope of Environmental Microbiology
- **1.2** Characteristics of major groups of microbes
- **1.3** Level of microbial diversity, distribution of microorganism and microbes of extreme environment
- **1.4** Microbial pathogen and their control

**Unit II. Microbial Ecology**

- **2.1** Mode of microbial nutrition
- **2.2** Ecological interactions of microbes and indicator microorganism
- **2.3** Effects of environmental factors (light, temperature, moisture, pH) on microorganisms
- **2.4** Biodegradation of organic pollutants by microorganisms
- **2.5** Determination of microbial growth (bacteria and fungi)

**Unit III. Basic and Environmental Biotechnology**

- **3.1** Concept, history and scope of Biotechnology
- **3.2** Plant tissue culture: General introduction, scope, cellular differentiation, totipotency
- **3.3** Recombinant DNA technology: Gene cloning, cDNA libraries, choice of vectors, PCR, DNA finger printing.
- **3.4** Genetic improvement of industrial microbes and nitrogen fixers, fermentation technology, vermiculture technology
- **3.5** Bioremediation: Types, advantages and applications
- **3.6** Bio-indicators, bio-fuels and biosensors

**Unit IV. Environmental Toxicology**

- **4.1** Definition, concept and scope of Environmental Toxicology
- **4.2** Xenobiotics- Dyes and Detergent, Food Additives, Pesticides and Heavy metals
- **4.3** Biotransformation: Principle, biotransformation enzymes, biotransformation for gaseous toxicants
- **4.4** Bioaccumulation: Principle, sub-lethal and indirect effects of bioaccumulation

**Unit V. Toxicity assessment, System Toxicity and Risk Assessment**

- **5.1** *In-vivo* and *in-vitro* toxicity assessment
- **5.2** Acute, sub-acute, sub chronic and chronic toxicity test, concept of bioassay, threshold limit value, margin of safety, therapeutic index
- **5.3** LD50, LC50, EC50, and IC50
- **5.4** Translocation and mechanism of toxicants (Absorption, distribution &excretion of toxic agents)
- **5.5** Risk Assessment (Models, Methods and Management)

**Course Code: SOLS/EVS-E- 003**

**Course Title: DSE Practical** **(02 credits)**

**(DSE-1 Research Methodology and Environmental Statistics)**

1. Experimental design/construction of hypothesis
2. Methods of collection, presentation and analysis of data
3. Measurement of Standard deviation, Standard error, Mean deviation correlation and regression
4. Chi square tests
5. ANOVA

***OR***

**(DSE-2 Environmental Microbiology, Biotechnology and Toxicology)**

1. Preparation of culture media and sterilization techniques
2. Protocol for PCR and DNA finger printing
3. To isolate, culture and mass-multiplication of beneficial microorganisms and prepare a biofertilizer inoculant suitable for soil application.
4. To separate and visualize DNA fragments by size using Agarose Gel Electrophoresis.
5. To assess the acute toxicity of an environmental sample using biological test organisms and determine toxicity endpoints such as $LC_{50}$ (lethal concentration) or $EC_{50}$ (effective concentration).

## SWAYAM 1: Environment and Development

**By Prof. Ngamjahao Kipgen, IIT Guwahati**

**https://onlinecourses.nptel.ac.in/noc21_hs83/preview**

**Course layout**

**Week-1:** Introduction: Development, economic growth and sustainable development, Basic ecosystem ecology

**Week-2:** Environmentalism, Environmental Movement, Environmentalism in the global south

**Week-3:** Approaches to environment: Ecofeminism, Feminist political ecology, Marxism and ecology

**Week-4:** Debates on environmental ethics: Deep ecology, Gandhi and ecology, Social ecology

**Week-5:** Religion, environment and conservation: Religion, environment and historical roots of ecological crisis, Biodiversity conservation ethics in Buddhism and Hinduism, Christian religion in the age of ecological crisis

**Week-6:** Natural resource management, Common property vs. private property,Livelihoods, forests, and conservation

**Week-7:** Displacement, dispossession and development: Conservation-induced displacement, Environment impact assessment and national rehabilitation & resettlement policy, Dispossession and land acquisition

**Week-8:** Mainstream development trajectory: Strengthening or weakening of indigenous peoples: Mining, development, and indigenous people, Competing visions of development along the Narmada, Dams, development, and resistance: case studies

**Week-9:** Gender and development: Development theory and gendered approach to development, Gender, environment & sustainable development

**Week-10:** Environment and climate change: Climate change interventions and policy framework, Eastern Himalayas and climate change

**Week-11:** Belief and knowledge systems, biodiversity conservation and sustainability: Ecological knowledge, biodiversity conservation and sustainability, Traditional religion and conservation of nature in Northeast India: Case study

**Week-12:** Local knowledge in the environment-development discourse: Indigenous knowledge, environment and development, Relevance of indigenous knowledge: case study

# SWAYAM 2: Municipal Solid Waste Management

**By Prof. Ajay Kalamdhad, IIT Guwahati**

**https://nptel.ac.in/courses/105103205**

## Course Details

### Module 1 : Evolution, Sources, Types and Generation of Solid Waste

- Lec 1: Introduction to solid waste
- Lec 2: Functional elements
- Lec 3: Types and sources of solid waste
- Lec 4: Sampling and characteristics
- Lec 5: Estimation of solid waste quantity
- Lec 6: Factors affecting solid waste generation rate

### Module 2: Waste Handling, Storage, Processing and Types of Collection of Solid Waste

- Lec 7: Handling, separation and storage at source
- Lec 8: Processing at source
- Lec 9: Primary collection
- Lec 10: Types of collection system

### Module 3 : Analysis of Solid Waste Collection System and Types of Transfer Station

- Lec 11: Analysis of collection system (Part I)
- Lec 12: Analysis of collection system (Part II)
- Lec 13: Analysis of collection system (Part III)
- Lec 14: Need and types of transfer station

### Week 4: Solid Waste Transport Means, Methods, Separation and Processing

- Lecture 15: Transport means and methods
- Lecture 16: Unit operation for component separation
- Lecture 17: Material recovery facilities (MRF)
- Lecture 18: Recycling of dry waste components

### Week 5: Incineration

- Lecture 19: Waste as a fuel
- Lecture 20: Incineration/Combustion
- Lecture 21: Flue gas characteristics and treatment

- Lecture 22: Solid residue generation, characterization and treatment
- Lecture 23: Waste-to-energy (WtE) plants (case studies) pyrolysis and gasification

**Week 6: Composting - I**

- Lecture 24: Definition and phases of composting
- Lecture 25: Factors affecting composting process
- Lecture 26: Types of composting – I

**Week 7: Composting – II**

- Lecture 27: Types of composting - II
- Lecture 28: Compost quality
- Lecture 29: Vermicomposting

**Week 8: Anaerobic Digestion**

- Lecture 30: Definition, stages and factors affecting anaerobic digestion
- Lecture 31: Pretreatment and co-digestion for enhancement of biogas production
- Lecture 32: Types of biogas digesters

**Week 9: Landfill - I**

- Lecture 33: Site selection and types of landfill
- Lecture 34: Leachate collection and treatment

**Week 10: Landfill - II**

- Lecture 35: Landfill gas collection and treatment
- Lecture 36: Design of landfill & Bio-minning of old dumpsite

**Week 11: Special Waste and Integrated Solid Waste Management**

- Lecture 37: Construction and demolition waste
- Lecture 38: Management of bio-mediacal, e-waste and inert waste
- Lecture 39: Integrated solid waste management (ISWM)
- Lecture 40: Municipal solid waste management rules

**Week 12: Finance and PPP Related to Solid Waste Management**

- Lecture 41: Financing in MSWM projects
- Lecture 42: Public-Private-Partnership (PPP)
- Lecture 43: Public-Private-Partnership (PPP) in MSWM projects

# Second Semester for 1-year M.Sc. program

**Course Code: SOLS/EVS-C- 005**
**Course Title: DSC-1 Environmental Management: EIA and Environmental Auditing (05 credits)**

**Unit I. Environmental Impact Assessment (EIA)**

- **1.1** Concept, scope and objectives of EIA
- **1.2** Evolution of EIA and developmental projects under EIA
- **1.3** Protocol for Environmental Impact Statement (EIS)
- **1.4** EIA guidelines 1994: Notifications of Government of India
- **1.5** EIA Notification 2006 and subsequent modifications

**Unit II. Methods of Impact Analysis**

- **2.1** Procedure of EIA
- **2.2** Impact assessment methodologies (Ad-hoc, Simple Checklist, Overlays, Matrices, Network, Combination Computer aided)
- **2.3** Impact prediction on air, water, land, biota, socio-economic environment
- **2.4** Concept of Cumulative Environmental Impact Assessment (CEIA)

**Unit III. Statuary Clearance Procedure and Public Consultation**

- **3.1** Expert Appraisal Committee(EAC)
- **3.2** Environmental Clearance, Wildlife Clearance and Forest Clearance
- **3.3** State Expert Appraisal Committee (SEAC) and State EIA Authority (SEIAA)
- **3.4** Concept, objectives and procedures of Public Consultation

**Unit IV. Post-Project Monitoring and Environmental Auditing**

- **4.1** Principles and guidelines of environmental auditing
- **4.2** General Audit: Methodology and basic structure of environmental auditing
- **4.3** ISO 14000 series and ISO 9000 series

**Unit V. Environmental Management and Management Plan**

- **5.1** Concept, objectives and scope of environmental management.
- **5.2** Guidelines for EMP
- **5.3** Development of EMP
- **5.4** Rehabilitation and resettlement
- **5.5** Compensatory Afforestation
- **5.6** Green belt development

**Course Code: SOLS/EVS-C- 006**
**Course Title: DSC-2 Environmental Laws, Ethics and Policies (05 credits)**

**Unit I. National and International Efforts for Environmental Protection**

- **1.1** Brief introduction about the structure of Indian Constitution
- **1.2** Environmental protection in the Indian Constitution
- **1.3** Major Environmental issues, challenges and its response at national and international Level
- **1.4** International and national efforts related to environmental Pollution, Climate change, Green house Gas emission, Ozone layer depletion and biodiversity conservation)

**Unit II. National Environmental Laws**

- **2.1** Indian Forest Act 1927; The Forest Conservation Act 1980, and Forest conservation Rules 2003
- **2.2** Wildlife Protection Act 1972 and its successive amendments
- **2.3** Biological Diversity Act 2002 and Biological Diversity Rules 2004
- **2.4** Water (Prevention and Control of Pollution) Act 1974 and Rules 1975 and subsequent amendments
- **2.5** Air (Prevention and Control of Pollution) Act 1978 and Rules 1982 and successive amendments
- **2.6** The Environmental (Protection) Act 1986 and its amendment in 1991, The environment (Protection) Rules 1986
- **2.7** The National Green Tribunal Act 2010
- **2.8** The Public Liability Insurance Act 1991

**Unit III. National Laws related to waste management**

- **3.1** Biomedical Waste Management rules, 2016, as Amended 2019
- **3.2** Hazardous and other waste (Management & Transboundary movement) Rules,
- **3.3** Plastic waste management rules 2016, as amended 2021
- **3.4** Solid waste management rules 2016
- **3.5** E-waste rules 2016 and E-waste (Management) Amendment Rules, 2018

**Unit IV. National Policies**

- **4.1** Forest Policy
- **4.2** Environmental Policy
- **4.3** Water Policy
- **4.4** Disaster Management Policy

**Course Code: SOLS/EVS-C- 007**
**Course Title: DSC-3 Environmental Geosciences and Disaster Management (05 credits)**

**Unit I. Fundamentals of Environmental Geosciences and Earth System**

- **1.1** Definition, concept and scope of Environmental Geosciences
- **1.2** Origin and evolution of the Earth; plate tectonics, rocks and their classification
- **1.3** Relationship among various geospheres
- **1.4** Energy budget and thermal environment of the Earth

**Unit II. Environmental Geochemistry and Land use Planning**

- **2.1** Concept, importance and use of the Earth elements
- **2.2** Weathering, soil formation, soil profile, soil classification and distribution
- **2.3** Land use planning: Soil survey, methods of site selection and evaluation

**Unit III. Earth's Processes and Geological Hazards**

- **3.1** Catastrophic geological hazards, hazards in Himalayan and coastal areas
- **3.2** Terrestrial hazards; floods, landslides, cloud burst, earthquakes, volcanism, avalanche and glacier lake outburst
- **3.3** Coastal hazards; Tsunami, storms in oceans, ice sheets and fluctuation s of sea levels, marine pollution by toxic wastes

**Unit IV. Disaster Management**

- **4.1** Introduction and definition of vulnerability, risk, hazard, disaster and catastrophe
- **4.2** Impact of disaster on economy and society
- **4.3** Disaster management cycle
- **4.4** Disaster management and sustainability

**Unit V. Disaster Mitigation and Risk Reduction**

- **5.1** Risk and vulnerability assessment
- **5.2** Disaster preparedness; information, education, awareness and communication
- **5.3** Disaster mitigation; approaches and strategies
- **5.4** Disaster response and planning; Search, Rescue and evacuation, damage, community health and casualty management
- **5.5** Disaster recovery: social and economic aspects of rehabilitation and resettlement
- **5.6** Prediction and perception of the hazards
- **5.7** Community based disaster risk reduction strategies

**Course Code: SOLS/EVS-C- 008**

**Course Title: DSC Practical (03 credits)**

1. Presentation of procedure of Environmental Impact Assessment (EIA) through flowchart
2. Presentation of procedure of Environmental Clearance through flowchart
3. Presentation of procedure of Forest Clearance through flowchart
4. Presentation of procedure of Environmental Auditing through flow chart
5. Presentation of procedure of Environmental Management Plan (EMP) through flow chart
6. Presentation of salient features of Wildlife Protection Act 1972
7. Presentation of salient features of Water (Prevention and Control of Pollution) Act 1974
8. Presentation of salient features of the Air (Prevention and Control of Pollution) Act 1981
9. Presentation of salient features of The Environmental (Protection) Act and Rules 1986
10. Presentation of salient features of The Indian Forest Conservation Act 1980
11. To understand the interior of the Earth
12. To understand the process of soil formation
13. To study the soil profile
14. To study the classification and orders of soil
15. To study the various soil types of India

**Course Code: SOLS/EVS-E- 004**

**Course Title: DSE-1 Spring-shed Conservation and Management (04 credits)**

**Unit I: Introduction to Springs and Spring-Sheds**

**1.1** Definition, scope and importance of spring-sheds

**1.2** Types and Classification of Springs: Gravity, artesian, contact, fracture, and solution springs.

**1.3** Hydro-geological Framework of Spring Systems: Structure of aquifers; groundwater flow in mountainous terrains.

**1.4** Ecological and Socioeconomic Importance of Springs: Role in drinking water, irrigation, biodiversity, and community livelihoods.

**Unit II: Hydrological and Climatic Influences**

**2.1** Watershed and Spring Hydrology: Rainfall-runoff processes, infiltration, percolation, and aquifer recharge.

**2.2** Impacts of Land Use and Land Cover Change (LULC): Effects of deforestation, agriculture, road construction, and urbanization.

**2.3** Climate Change and Seasonal Variability: Impacts on spring discharge, recharge cycles, and long-term water availability.

**2.4** Monitoring Tools and Techniques: Use of rain gauges, piezometers, flow meters, and soil moisture sensors.

**Unit III: Spring-Shed Management Approaches**

**3.1** Spring Rejuvenation Techniques: Implementation of recharge structures like trenches, percolation pits, check dams, and ponds.

**3.2** Delineation and Mapping using GIS & Remote Sensing: Application of geospatial tools for spring-shed mapping and intervention planning.

**3.3** Community-Based Water Resource Management: Participatory rural appraisal (PRA), stakeholder engagement, and local knowledge integration.

**3.5** Demand and Supply Side Water Management: Strategies for efficient water use, rainwater harvesting, and equitable distribution.

**Unit IV: Conservation and Policy Perspectives**

**4.1** National Water Policies and Programs: Overview of Jal Shakti Abhiyan, Atal BhujalYojana, MGNREGA in spring conservation.

**4.2** Institutional and Governance Framework: Roles of Panchayati Raj institutions, Van Panchayats, NGOs, and water user groups.

**4.3** Environmental and Social Safeguards: Inclusion of gender, marginalized groups, and mechanisms for conflict resolution.

**4.4** Ecosystem Services and Valuation of Springs: Assessing provisioning, regulatory, cultural, and supporting services of spring ecosystems.

**Course Code: SOLS/EVS-E- 005**

**Course Title: DSE-2 Himalayan Wildlife Management (04 credits)**

**Unit I. An Introduction to the Himalaya**

- **1.1** Physiography- location, expansion and importance
- **1.2** Origin and evolution of the Himalaya
- **1.3** Himalayan Environment
- **1.4** Natural resources of the Himalaya
- **1.5** Fragility of the mountain ecosystem

**Unit II. Wildlife of the Himalaya**

- **2.1** Unique characteristics and importance of the wildlife
- **2.2** Himalayan biodiversity
- **2.3** Endemism
- **2.4** Depletion of Himalayan wildlife

**Unit III. Manifestation of Himalayan Wildlife**

- **3.1** Himalayan wild Mammals
- **3.2** Himalayan wild Birds
- **3.3** Himalayan Reptiles and Amphibians
- **3.4** Himalayan Fish
- **3.5** Himalayan Butterflies
- **3.6** Rare and Endangered Himalayan wild flora

**Unit IV. Conservation and Management**

- **4.1** Administrative and legislative measures for protection of wildlife
- **4.2** Protected areas (National parks, sanctuaries, biosphere reserves) in the Himalaya
- **4.3** Tiger Project, Project Elephant, Project Rhino, Project Snow Leopard
- **4.4** Man-Wildlife Conflict: agriculture-wildlife conflict
- **4.5** Wildlife Protection Act 1972 and successive amendments
- **4.6** Problems in implementation of the Wildlife Protection Act

**Course Code: SOLS/EVS-E- 006**

**Course Title: DSE Practical** **(02 credits)**

**(DSE-1 Spring-shed Conservation and Management)**

1. To identify, document, and map springs in a designated area.
2. To measure the quantity of water discharged by a spring.
3. To assess the land use and land cover (LULC) of the spring catchment area.
4. To evaluate the basic quality of spring water for human use.
5. To plan and construct basic recharge or conservation structures in a spring-shed.

***OR***

**(DSE-2 Himalayan Wild Life Management)**

1. Documentation of Wild life conflict hotspots using field mapping & interviews.
2. Mitigation measure evaluation for Himalayan Wild life
3. Preparation of a micro-management plan for a Himalayan wildlife habitat.
4. Assessment of anthropogenic pressures to Himalayan Wild life
5. Preparation of corridor maps for species movement (least-cost path analysis).